Renewable and Sustainable Energy Reviews 14 (2010) 1744–1762

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

A review on global wind energy policy

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ARTICLE INFO

Article history:
Received 19 January 2010
Accepted 2 March 2010

Keywords:
Wind energy
Policy
FIT
Incentives
Target implementation

ABSTRACT

With the increasing negative effects of fossil fuel combustion on the environment in addition to limited stock of fossil fuel have forced many countries to inquire into and change to environmentally friendly alternatives that are renewable to sustain the increasing energy demand. Energy policy plays a vital role to mitigate the impacts of global warming and crisis of energy availability. This paper explores the wind energy industry from the point of view of the wind energy policy. It is noticed that energy policy could help increasing wind power generation as well as stimulating the energy industry. It may be stated that without specific energy policy, a country would not be able to solve the acute problems like reducing greenhouse gases (GHGs) emission, scarcity of energy, etc. This paper discussed the existing successful energy policies for few selected countries. Based on literatures, it has been found that FIT, RPS, incentives, pricing law and Quota system are the most useful energy policies practiced by many countries around the world. Then, status of wind energy policy for Malaysia was investigated and compared with few selected countries around the world.

Contents

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1364-0321/$ – see front matter
doi:10.1016/j.rser.2010.03.007

Nomenclature

ACT	Australian Capital Territory
ARRA	American Recovery and Reinvestment Act
ASP	Approved Service Projects
Auswind	Australian Wind Energy Association
AWEA	American Wind Energy Association
BTU	British thermal unit
BWE	German Wind Energy Association
CO_2	Carbon Dioxide
DKK	Danish Krone (Currency of Denmark)
DOE	Department of Energy
DTE	Ministry of Transport and Energy
EEG	Renewable Energy Sources Act
EU	European Union
FIT	Feed-In-Tariff
FY	Fiscal Year
GHG	Green House Gas
HPP	Hydro Power Plant
IPP	Independent Power Producers
ITA	Investment Tax Allowance
ITC	Investment Tax Credit
JWEA	Japanese Wind Energy Association
JWPA	Japanese Wind Power Association
kWh	kilo Watt hour
MENR	Ministry of Energy and Natural Resource
MRET	Mandatory Renewable Energy Target
MW	Mega Watt
NDRC	National Development and Reform Commission
NREA	New and Renewable Energy Agency
OECD	Organization for Economic Cooperation and Development
PS	Pioneer Status
PTC	Production Tax Credit
PTM	Pusat Tenaga Malaysia
PV	Photovoltaic
R&D	Research and Development
RE	Renewable Energy
REPPA	Renewable Energy Power Purchase Agreement
RES	Renewable Electricity Standard
RET	Renewable Energy Technology
RM	Ringgit Malaysia
RPS	Renewable Portfolio Standard
SDPC	State Development and Planning Commission
SETC	State Economic and Trade Commission
SIRIM	Standards and Industrial Research Institute of Malaysia
SREP	Small Renewable Energy Power
TNB	Tenaga Nasional Berhad
TPP	Thermal Power Plant
UKM	Universiti Kebangsaan Malaysia
UM	University of Malaya
UNFCCC	United Nations Framework Convention on Climate Change
UPM	Universiti Putra Malaysia
USM	Universiti Sains Malaysia
UTM	Universiti Teknologi Malaysia

1. Introduction

1.1. The energy policy

Energy policy is the manner and the country's strategy in which a given entity (often governmental) decides to address issues of energy development along with the development of the energy industry to sustain its growth including energy production, distribution and consumption. The attributes of energy policy may include legislation, international treaties, incentives to investment, the country's targeted energy generation, guidelines for energy conservation, strategies to stimulate the energy industry, taxation and other public policy techniques as well as the focus on new (usually renewable) energy sources. However, there are many countries that do not have specific policies on wind energy, which means that wind energy, if any, has not yet been explored as an alternative [1,2].

1.2. Indispensability of wind energy

Wind energy, the world's fastest growing energy source, is a clean and renewable source of energy that has been in use for centuries in Europe and more recently in the United States and other nations. Wind turbines, both large and small, produce electricity for utilities and home owners and remote villages.

A new approach to wind energy offers a clear path to a more secure and prosperous future and more livable world for the human being as well as for the entire living creature. Renewable energy sources are easily accessible to mankind around the world. It is not only available in a wide range but is also abundant in nature. Increased use of wind energy and other renewable energy sources will spur economic growth, create job opportunity, enhance national security, protect consumers from price spikes or supply shortages associated with global fuel markets and dramatically reduce the pollutant that is warming the planet which causes greenhouse effect [2–4].

Renewable energies are regarded as a key factor in mitigating global climate change in the future. Among various renewable energy sources, wind energy in particular has achieved maturity in the energy market, and has experienced the greatest growth worldwide over the past few years, as illustrated in Fig. 1 [5]. According to the assessment of the Intergovernmental Panel on Climate Change concerning wind energy potential, intermittent wind power on a large grid can contribute an estimated 15–20% of

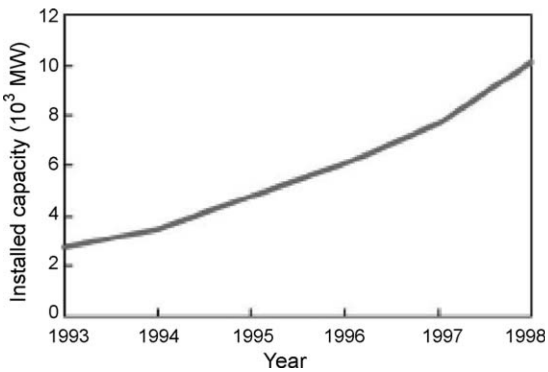

Fig. 1. Worldwide development of wind power [5].

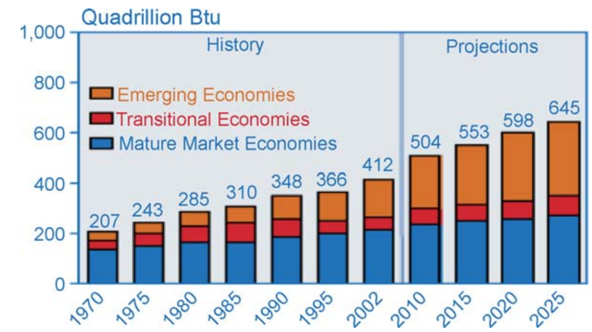

Fig. 2. World energy demand growth [13].

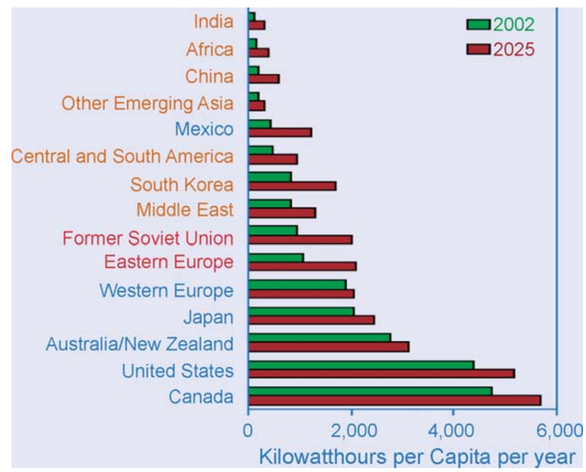

Fig. 3. Residential electricity consumption per capita [14].

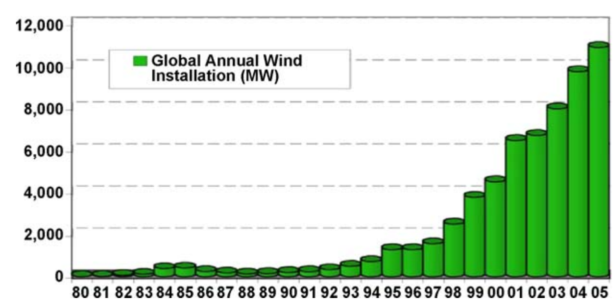

Fig. 4. Global annual wind installations (MW) 1980–2005 [17].

annual electricity production without special arrangements for storage, backup, or load management [6].

Wind energy was the fastest growing energy technology in the 90s, in terms of percentage of yearly growth of installed capacity per technology source. As Paul [7] noticed wind has advanced more quickly to commercialization than other technologies such as solar power, fuel cells and wave power with relatively little R&D expenditure**.** The growth of wind energy, however, is not evenly distributed around the world as shown in Table 1. By the end of 1999, around 70% of the world-wide wind energy capacity was installed in Europe, a further 19% in North America and 9% in Asia and the Pacific [8].

There has been a significant increase in electrical energy demand due to the economical and technological developments over the world [9]. The global economy grew 3.3% per year over the past 30 years and in this period electrical energy demand increased 3.6% [10]. The electrical energy production of the world in 2004 was 17,450 TWh [11] and it is estimated that the world will consume 31,657 TWh in 2030 [12]. According to International Energy Outlook 2009, World energy consumption will increase from 472 quadrillion Btu in 2006 to 552 quadrillion Btu in 2015 and 678 quadrillion Btu in 2030—a total increase of 44% over the projection period 2006–2030 as shown in Figs. 2 and 3. Fossil fuel in the world is limited but most of the electrical energy has been derived from fossil fuel and in the future world will face the fuel crisis [13].

So to tackle the future crisis it is needed to study the electrical energy production with renewable energy such as wind, solar, biomass, hydro, etc. [9]. Among all the renewable energy sources, the greatest increase will be in wind energy production as shown in Fig. 4. This rate reached 20% in Denmark, 6% in Germany for the year 2003 [15,16].

Global warming and the associated changes in the world climate pattern have been accepted world wide as the gravest threat to humanity in the 21st century. Consequentially the United Nations Framework Convention on Climate Change conference (UNFCCC) has to establish a legally binding international agreement, whereby all the participating nations commit themselves to tackling the issue of global warming and greenhouse gas emissions and they targeted an average reduction of 5.2% from 1990 levels by the year 2012. Large-scale and global environmental hazards to human health include climate change, stratospheric

Table 1
Operational wind power capacity world-wide [8].

Region	Installed capacity (MW)				
	End of 1995	End of 1997	End of 1999	End of 2000	End of 2001
Europe	2518	4766	9307	12972	16362
North America	1676	1611	2619	2695	4440
South & Central America	11	38	87	103	103
Asia & Pacific	626	1149	1403	1795	2162
Middle East & Africa	13	24	39	141	203
Total world-wide	4844	7588	13455	17706	23270

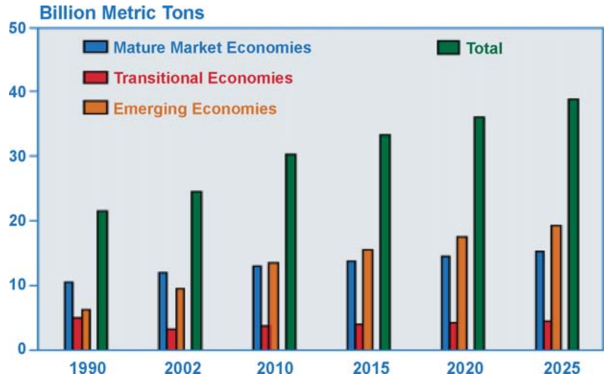

Fig. 5. World energy related greenhouse gas emissions (CO_2 eq.) [14].

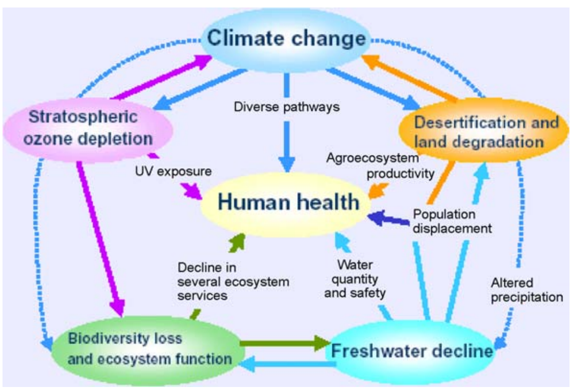

Fig. 6. Global environmental change and its effect on human health [20].

ozone depletion, loss of biodiversity, changes in hydrological systems and the supplies of freshwater, land degradation and stresses on food-producing systems. Air pollution levels of most populated cities in the world are high and continue to climb. Indoor air pollution from burning solid fuels causes a lot of death in Asia and it is about 65% of the world total. The projected GHGs gas emissions and reason behind the health hazardous is shown in Figs. 5–7 [18,19].

As a result of concerns about climate change, increase the energy consumption rate, international agreements to reduce the GHGs emission and thinking about the availability of wind energy governments worldwide are beginning to establish national goals

Fig. 7. Air pollution from World War II production [21].

for the provision of electricity from renewable energy and hence try to set-up the various wind energy policy in various countries [22,23]. In this paper the existing various wind energy policies are discussed briefly. There are many literatures that discussed mainly about the energy policies of a country or one or two energy policies of a country. However, in this paper authors discussed and compared energy policies for eleven countries around the world. It is expected that it will be very useful for policy makers, energy producing industries, research organizations, Government for many parts of the world.

2. Policies of different countries

A variety of policies like pricing laws, quota requirements, production incentives, tax credits, trading systems, etc. have been developed and implemented to promote the use of renewable energy (RE) [24]. The main objective of this strategies are—reducing reliance on fossil fuels, reducing the environmental impacts of the energy sector and encouraging new industrial development [25]. Yet the feed-in tariff (FIT) and the renewable portfolio standard (RPS) are the most popular. Though there existing a lot of debates surround their effectiveness, with some expectation that a choice has to be made between them [26–28]. For this the countries can decide which RE policy can be applicable in their own particular circumstances and objectives. According to Ekins [29], "No optimal model has emerged, and probably none will do so in the contexts that is shaped by different histories and cultures.

2.1. Wind energy policy in North America

2.1.1. United States

2.1.1.1. Renewable portfolio standard. RPS-type mechanisms have been adopted in Britain, Italy and Belgium as well as in 27 U.S.A. states, A renewable portfolio standard is a regulation that requires the increased production of energy from renewable energy sources, such as wind, solar, biomass, and geothermal. Another common name for the same concept is renewable electricity standard (RES) [30].

The energy policy of the United States is determined by federal tax incentives, state renewable portfolio standards and local public entities in the United States [31] which address issues of energy production, distribution and consumption such as building codes and gas mileage standards. Several mandates have been proposed over the years, such as gasoline will never exceed $1.00/gallon and the United States will never again import as much oil as it did in 1977 [32], but no comprehensive long-term energy policy has been proposed, although there has been concern over this failure [33]. Three Energy Policy Acts have been passed, in 1992, 2005, and 2007. The "Energy Independence and Security Act of 2007" has a significant impact on U.S. Energy Policy [34].

2.1.1.2. Incentives. In March 2009, Vice President Joe Biden announced plans to invest $3.2 billion in energy efficiency and energy conservation projects in the United States. The Energy Efficiency and Conservation Block Grants program, funded by President Obama's American Recovery and Reinvestment Act, will provide grants for projects that reduce total energy use and fossil fuel emissions, and improve energy efficiency nationwide [35].

DOE and the U.S. Environmental Protection Agency [36] have released an updated version of the National Action Plan for Energy Efficiency "Vision for 2025: A Framework for Change", which lays out a proposed energy efficiency action plan for state policy makers. If implemented by all states, the plan could lower energy demand across the country by 50%, achieve more than $500 billion

in net savings over the next 20 years, and reduce annual greenhouse gas emissions equivalent to those from 90 million vehicles. The report, which was released under the National Action Plan for Energy Efficiency initiative, was produced by more than 60 energy, environmental, and state policy leaders from across the country [36].

The American Wind Energy Association (AWEA) reported in its third quarter (Q3) market report that the U.S. wind energy industry installed 1649 megawatts (MW) of new power generating capacity in the third quarter [37]. Wind energy generating capacity in the US increased from about 2500 MW in 1999 to about 21,000 MW in mid 2008 and about 28,000 MW in early 2009 [38]. This expansion of generating capacity was accomplished by innovations in wind turbine design, learning by the wind and utility industries and economics of scale. At the same time, the costs of installed utility-scale wind projects (in constant $/kW) declined until the early 2000s and then generally increased [39]. Increasing the Wind Energy's Contribution to U.S. Electricity Supply, a report released in May 2008 by the U.S. Department of Energy, concludes that the U.S. possesses sufficient and affordable wind resources to obtain at least 20% of its electricity from wind. Achieving the 20% wind vision will dramatically cut greenhouse gas emissions [37].

On February 17, 2009, President Obama signed into law The American Recovery and Reinvestment Act [40] of 2009.

ARRA repeals the subsidized energy financing limitation on the investment tax credit (ITC) in order to allow businesses and individuals to qualify for the full amount of the ITC even if such property is financed with industrial development bonds or through any other subsidized energy financing. Previously, the ITC had to be reduced if the property qualifying for the ITC was also financed with industrial development bonds or through any other federal, state or local subsidized financing program.

ARRA extends the production tax credit (PTC) for wind energy for three years, through December 31, 2012. In order to help monetize the ITC, ARRA allows taxpayers who are eligible for an ITC (including ITCs claimed in lieu of PTCs) to receive an equivalent financial grant from the Treasury Department, in lieu of claiming the credit, if the property is either:

- Placed in service in 2009 or 2010, or
- Placed in service before the credit termination date (January 1, 2013 for wind projects), provided the construction of such property began in 2009 or 2010.

ARRA amends the Energy Policy Act of 2005 to create a new loan guarantee program (LGP) at the Department of Energy funded at $6 billion. The program applies to both "commercial" and "innovative" technologies; generation projects, transmission and manufacturing facilities are eligible. To qualify for a loan, projects must commence construction no later than September 30, 2011.

2.1.1.3. Reduction of GHGs. American Wind Energy Association seeks climate legislation that includes an aggressive near-term goal, such as a 15–20% carbon dioxide reduction by 2020, in order to promote a near-term shift to renewable energy and get the quick start on greenhouse gas emissions reductions [40].

2.1.1.4. Target. AWEA seeks a national RES that calls for 25% of the nation's electricity to come from renewable energy by 2025. An aggressive near-term target, such as the 10% by 2012 objective called for in the Obama-Biden New Energy for America plan, is essential to ensure rapid renewable energy deployment [41].

2.1.1.5. Research and development. According to Gramlich [41] federal funding for wind energy research and development (R&D) and other programs is inadequate, especially when compared with funding levels for other fuels and energy sources. The U.S. Department of Energy wind program currently receives about $50 million annually, which is well below its all-time high of $63 million appropriated in Fiscal Year 1980.

The renewable electricity standard, also known as a renewable portfolio standard, uses market mechanisms to ensure that a growing percentage of electricity is produced from renewable sources, like wind power. The RES provides a predictable, competitive market, within which renewable generators compete with each other to lower prices. RES policies currently exist in 28 U.S. states, but not at the national level.

The so-called "feed-in-tariffs" that have provided a stable profitable market for wind generators in Denmark and Sweden historically, and Germany and Spain currently, no longer exist in the United States [42].

2.1.2. Canada

Canada is the 5th largest producer of energy in the world, producing about 6% of global energy supplies [43]. The energy sector is an important part of Canada's economy in terms of investment, trade, income generation and employment [44]. It produces of total energy (all sources) (397.5 megatons of oil equivalent (16,640 PJ)). On an energy basis, uranium accounts for 33% of production, natural gas 30%, petroleum 23%, coal 6%, and renewable (hydro, wind and biomass) 8% [45]. It is also the 8th largest consumer (269 megatons of oil equivalent (11,300 PJ)) [46].

2.1.2.1. Feed-in-Tariff. A Feed-in Tariff is an incentive program that stimulates the renewable energy sector through government legislation. It requires electricity utilities to buy renewable energy at above market rates (set by the government) from anyone who wishes to produce renewable electricity. This has been shown to be one of the most effective ways to jump-start renewable energy production and adoption by rewarding small and medium scale producers as well as industrial scale producers of green power. Ontario introduced a feed-in tariff in 2006, and revised it in 2009 [47].

2.1.2.2. Growth & target. The installed capacity of wind generation in Canada had an average annual growth rate of 51% between 2000 and 2006. In 2006, 776 MW of new capacity was installed, and it is expected that, in 2007, wind-installed capacity will grow by a minimum of 500 MW. Fig. 8 shows the increase in wind generation installed capacity in Canada [48]. In 2006, Canada became one of 13 countries around the word that have 1 GW or more of installed wind-power capacity. The total installed wind capacity in Canada as of May 2007 was 1492 MW, out of which, 415 MW is in the province of Ontario. Because of the proposed changes in Ontario's power mix and the anticipated increase of wind share, OPA and Ontario's Independent Energy System Operator (IESO) commissioned studies about Ontario's future wind power and its integration in the system [49–51].

Canada's wind energy market experienced its second best year ever in 2007. A total of 386 MW of new wind energy capacity was

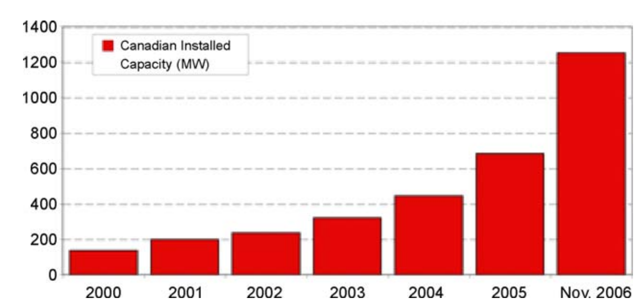

Fig. 8. Canadian installed capacity (MW) 2000–2006 [17].

installed in 2007, increasing Canada's total by 26%. Canada now has 1846 MW of installed wind energy capacity. Canada's federal and provincial governments have both developed policy frameworks to support the deployment of wind energy in Canada. If all of Canada's provincial governments/utilities meet their stated targets for wind/renewable energy development, it is anticipated that Canada will have a minimum of 12,000 MW of installed wind energy capacity by 2016.

2.1.2.3. Incentives. The Federal Government's eco-energy Renewable Power Program provides a production incentive of 1 cent/kWh for the first 10 years of production at a wind energy facility. Ontario has implemented a Standard Offer Contract (i.e. feed-in tariff) program for projects of 10 MW or less and similar programs are under consideration in other provinces [52].

The only exception is Alberta, where a deregulated market means that wind developers must build plants on a merchant basis. It also appears likely that wind energy projects will be able to create greenhouse gas emission offsets within both Federal and Albertan greenhouse gas emission regulatory frameworks that are to be put in place in 2008, providing an opportunity for wind energy projects to obtain some value for their environmental attributes in a domestic carbon market.

The industry does face a number of challenges that must be addressed to maximize the economic and environmental benefits of its massive wind energy potential. On the policy front, the federal eco-energy Renewable Power Program is likely to have fully allocated its funds in 2009 and it is not yet clear what form future federal support will take. Permitting and approval processes can still be made more efficient and streamlined. The availability of transmission capacity is also an emerging issue.

While public opposition to wind energy projects is still an issue with respect to a minority of projects in Canada, such opposition is gaining a higher profile in light of the rapid expansion of the industry. Finally, increased turbine costs and issues related to turbine availability are having an impact on the marketplace.

Small-scale diesel generators (50–100 kW) are only 25–35% efficient. Since costs for fuel in the remote off-grid communities, with diesel generation and freight costs, are three times more expensive than fuel prices elsewhere in Canada, due to transportation costs, renewable energy technologies (RETs) may make more economic sense in remote off-grid communities [53]. Presently, small-scale diesel generators provide power to over 300 off-grid communities in Canada with a combined population of over 200,000 people [54]. Generally speaking, there are three areas in which communities can focus in order to improve their energy systems: energy efficiency; energy conservation; and the switching of energy sources to renewable [55].

Accordingly, the future for Canada's wind industry looks bright with stable and sustainable growth foreseen for the next several years.

2.2. Wind energy policy in European Countries

2.2.1. Denmark

In 1973, practically all of the electricity in Denmark were generated in large, centralized thermal power stations [56]. Renewable electricity has played an important role in Denmark since the first oil shock in 1973 [57]. Wind energy has grown to a scale that will undoubtedly alter natural and cultural landscapes [58]. Denmark has been leading the development of modern wind power during the first part of its commercial history. Wind energy has gone through an incommensurable evolution, from small scale symbol of iconic value to a large-scale industries and opposition against new installations [59].

2.2.1.1. Policy and R&D. Denmark has a long tradition of exploiting wind power. Research and development of new kinds of wind turbines from the late 1970s, combined with favorable government grants towards wind power production, have created a Danish success story. In 2001, about 18% of Danish electricity consumption was supplied by wind power as opposed to 2% in 1990. Concurrently, Danish wind turbines have become a major export commodity with currency earnings of approximately DKK 12 billion in 2001 [60].

In the wake of the oil crisis of 1973, the Danish government published their new energy policy where Renewable energy, especially wind energy would play a role. This role has increased in following energy policies, especially supported by a bottom-up movement of entrepreneurs and cooperatives. Energy policy has included residency restrictions and own consumption minima, and a mandatory grid connection for de-central generation since 1979 to encourage this local movement [61]. Agreements with utilities for implementation targets and a kWh subsidy have led to a strong home market for the rising Danish wind industry and an implementation of wind energy making Denmark the country with the highest wind penetration in electricity supply: 23% in 2006.

The development of wind energy has been accompanied by a continuous development of energy policy and planning practice, as the technology grew in size, extent and significance. In 1990s, in spite of imposing the planning restriction, wind turbines continued to grow in capacity and size, making the majority of exclusive zone obsolete. A major contributor to the diminishing numbers of new turbines, however, was of economic nature: the former fixed feed-in-tariff was abolished after the year 2000, making wind energy investments increasingly dependent on market prices [57].

2.2.1.2. Incentive. Wind energy in Denmark generally enjoys a high public acceptance [62]. The main reason behind this was the ownership. Public regulation granted a proportion of the wind capacity to be erected by publicly owned utilities and more importantly, legislation stimulated the formation of local wind cooperatives with limited ownership of shares in wind turbine projects within residents' municipalities [63].

In the Electricity Reform Agreement of March 1999, it became possible for private individuals to submit applications for offshore farms next to the demonstration parks, with the possibility for co-ownership for consumers and other private investors. The Electricity Reform Agreement opened the electricity market for competition. The Agreement included prioritization of environmentally friendly generation, a consumer quota for Renewable Energy Resource (RER) and the announcement of a CO_2 emissions trading system, to be implemented in 2003. A target was set for a 21% deduction of CO_2 emissions in 2008–2012 compared to 1990 level.

2.2.1.3. Target. Danish energy policy for offshore wind power started in 1996, when the Danish government named their target of 4000 MW in 2030 in Energy 21. Because of the visual impact of (large) wind turbines and already a high deployment onshore, this offshore target has been formulated in order to achieve their objective of a 50% CO_2 reduction in 2030 compared to the 1990 level. In 1997, the study 'Offshore wind turbine Action Plan' showed offshore wind as an interesting renewable option that could reach competitiveness and designated five suitable areas for offshore wind. The Danish government decided to order the power producing companies to build 5 demonstration parks in these areas, totaling 750 MW to further investigate the technical, economical and environmental aspects.

In the recent Energy Strategy 2025 of 22 March 2004, the Ministry of Transport and Energy stated that the future of wind

energy in Denmark would mainly lie offshore, for which a significant growth is foreseen. The Policy Agreement of 29 March 2004 announced a call for bids for two offshore wind farms, each consisting of 200 MW [64].

By the end of 2001, capacity had grown to over 2800 MW and wind contributed nearly 12% of gross electricity consumption as shown in Fig. 8 [65]. In 2005, Denmark had installed wind capacity of 3129 MW, which produced 23,810 TJ of energy. Wind power provided 18.2% of the total gross electricity production. In 2006, the installed capacity increased to 3136 MW as stated in Table 2 [66].

2.2.2. Germany

Renewable energy policy in Germany began in 1974, after the first oil crisis [68]. Germany is a leader in Europe on shifting from conventional to renewable sources of energy [69]. Renewable energy technologies have deployed rapidly in Germany since 1990 largely as a result of energy policies adopted by the German government and the European Union [70].

2.2.2.1. Policies. The major government instruments that led to the rapid diffusion of wind power capacity at the end of the 1980s consisted of: the 100/250 MW program, the feed-in law and tax breaks, as well as the provision of low-interest loans [71]. Together with the 100/250 MW program and subsidies from various state programs, the Feed-In Law gave considerable financial incentives to investors, although less so for solar power due to the latter's high cost [72].

The Electricity Feed-in law was the progenitor of German wind power development in 1991. In 1997, the Federal Building Code included wind turbines as 'privileged building projects'; April 2000 saw the adoption of the Renewable Energy Sources Act (EEG); March 2001 saw the feed-in tariff model complying with the European State Aid and Competition Law, while in August 2004 the EEG was amended [73].

Germany has been extremely successful at rapidly transitioning toward renewable energy systems through feed-in tariffs. Using feed-in tariffs, Germany currently generates 12.5% of its electricity from renewable sources [74].

2.2.2.2. Target. Germany has pushed strongly for the development of renewable energies and their integration into the existing network. This is particularly the case for wind energy, where Germany had 20.7 GW onshore wind capacities in 2006; in addition about 7 GW are expected to be constructed offshore until 2015 and a long-term goal of 30 GW offshore is considered for 2030 [75]. At present, the technicalities of the integration of the offshore wind energy are being studied by industry and government; there is also a debate about the economic costs of integrating large-scale wind power into the German electricity grid [76].

Germany's federal goal is to achieve 30% of its electrical power generation from renewable sources by the year 2020 with a long-term goal of 50% by 2050 [77,78].

Germany's climate protection program, on October 18, 2000 declared with the targets of reduction of CO_2 emissions until 2005 by 25% (base year 1990), reduction of all 6 GHG emissions of the Kyoto protocol within the EU burden sharing by 21% and promotion of CHP to reduce CO_2 emissions (10 mio.t until 2005 and 23 mio.t until 2010 [79].

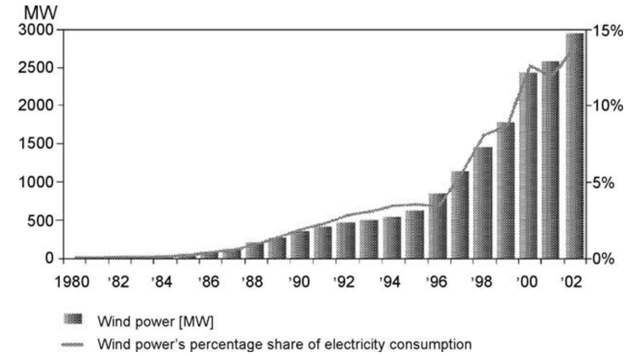

Fig. 9. Development of installed Danish wind capacity from 1980 to 2002 [67].

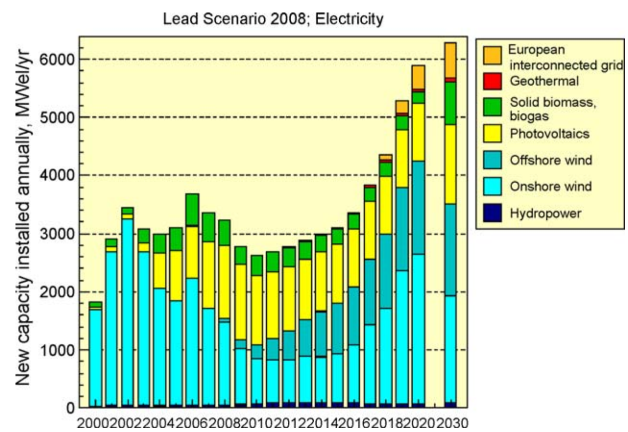

Fig. 10. Trends in new capacity installed annually for electricity generation from renewable energies for the period 2000–2020 and 2030 [81].

2.2.2.3. Incentives and R&D. To test the availability of wind energy within Germany the hourly wind feed-in during the period from 2006 till summer 2008 is obtained from the four German TSOs. The total output of wind parks was about 30 TWh in 2006, about 40 TWh in 2007, and about 22 TWh in the first half of 2008. Compared to the total demand for electricity in Germany of about 500 TWh wind energy still plays only a minor role. During the observation period the installed capacity increased from 18.5 GW to 23.4 GW putting it on a level playing field with nuclear and coal [80].

According to the Lead Scenario 2008 [81] to reach the target (30%) for 2020 is possible, and the continued steady expansion will amount to a renewable share of more than 50% in Germany's total gross electricity generation in 2030 as shown in Figs. 9 and 10.

Closely after the USA, Germany is the world's second largest user of wind power with an installed capacity of 23,903 MW by the end of 2008 [82] ahead of Spain which had an installed capacity of 16,740 MW [83] 20,301 wind turbines are located in the German federal area and the country has plans to build more wind turbines [84].

Recent data highlights Germany's success in meeting its ambitious goals for renewable energy production. Renewable energies achieved a share of 14.2% of gross electricity consumption in 2007—one-fifth more than the previous year. Wind energy supplied the largest share of the electricity generated from renewable sources [85].

Table 2
Installed wind capacity share in the electricity supply in Denmark by year [66].

Year	2001	2002	2003	2004	2005	2006	2007
Installed wind capacity (MW)	2489	2892	3117	3125	3129	3136	3125
Wind power share in the electricity supply (%)	12.1	13.8	15.8	18.5	18.5	16.8	19.7

With more than a third of the world's installed capacity, no other country has more wind turbines than Germany. According to figures from the German Wind Energy Association [82], 18,685 plants with a capacity of 20,622 megawatts were in operation at the end of 2006 [70].

It is considering three key dimensions as criteria for success behind the Germany's renewable energy policy: First, it addresses the familiar question of effectiveness of policy in its influence on the deployment of renewable energy technologies and on greenhouse gas emissions, Second, the effect of renewable policy on technological advance, third, is the effectiveness of policy in promoting German renewable technology exports and economic competitiveness [86].

Additionally, the Environment Ministry has proposed that the German Renewable Energy Law is to be revised so that offshore projects would receive a payment (€0.091 per kWh) for their electricity output over 12 years instead of the current 9 years. At the present time the payment is restricted to those installations which started operating before 2006 but an amendment would extend this date. Further amendments would reduce payments to some onshore wind turbines [73].

2.2.3. Turkey

Although Turkey has a wide range of energy resources, it is an energy importing country and More than about 60% of energy consumption in the country is met by imports and the share of imports continues to grow each year [87]. Turkey has a large potential for renewable energies and their technology is development enough to use this resources effectively [88]. In Turkey, electricity is produced by thermal power plants (TPPs), consuming coal, lignite, NG, fuel oil and geothermal energy, and hydro power plants (HPPs) [89]. Figs. 11 and 12 show the installed capacity of power and distribution of installed power capacity in Turkey respectively.

2.2.3.1. Policies. Turkey introduced its first law on the Use of Renewable Energy Resources for the Generation of Electrical

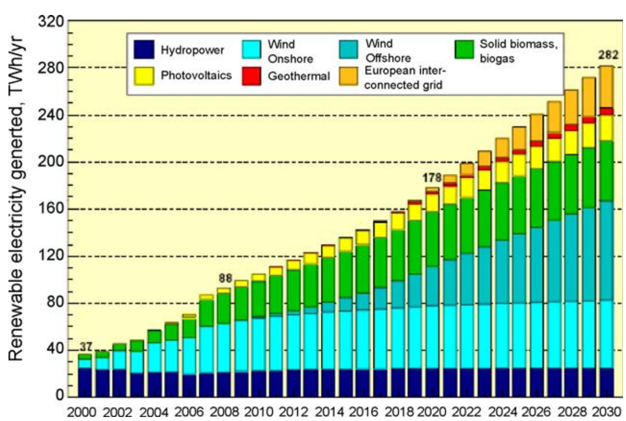

Fig. 11. Trends in electricity generation from renewable energies 2000–2030 [81].

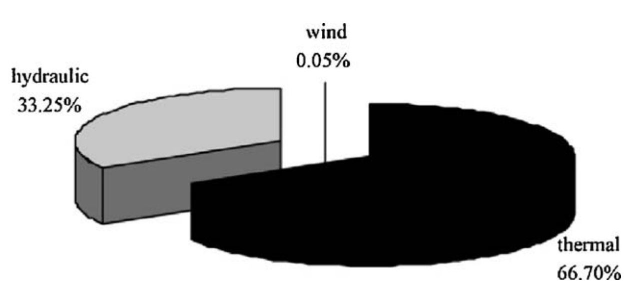

Fig. 12. Distribution of installed power capacity of Turkey [9].

Energy in May 2005, introducing tariff support for electricity produced by renewable sources. This tariff was increased slightly to €5–5.5 ct/kWh by a revision of the law in May 2007. The support was set out to last for seven years. While the level of support is low in comparison with other European countries, wind power producers are also free to sell to the national power pool or engage directly with eligible customers in bilateral agreements where prices are much higher than the guaranteed price [90].

A number of additional policy measures have helped to increase renewable production in Turkey in recent years. These include the obligation of the national transmission company to provide grid connection to all renewable power projects, and improved transmission links with the EU, which stabilize the power system. Furthermore, most restrictions on foreign investment in the Turkish power sector have been lifted [91].

2.2.3.2. Incentives. Energy development in Turkey has been dominated by public investment and management since independence in 1923, although several waves of liberalization have been launched since 1983, leading to a gradual opening of the Turkish energy market and improving the situation. Turkey has made early and extensive use of financing models such as build-own-operate (BOO) and build-own-transfer (BOT). As yet, however, no decisive breakthrough has been achieved [92]. In the last two years, several encouraging steps have been taken towards greater liberalization. The notion of privatization has been introduced into the Turkish constitution for the first time. Legislation was adopted in February 2001 to allow competition in the electricity market and adapt Turkey's legislation for European Union (EU) membership. A new Gas Market Law was adopted in May 2001 and insists on the reduction of CO_2 by 8% as Kyoto targets [93].

Turkey's renewable energy policies are being improved. Currently, there are a few Government-backed incentives to promote renewable energy investments. The MENR is preparing a draft legislation which would allow certain renewable energy projects (mainly geothermal and wind, but also solar, wave, waste and landfill gas only) to be built and operated by the private sector, and provide incentives for such system. This legislation would also set the buy-back rates for renewable electricity. MENR has announced a target for wind energy, namely 2% of the total installed capacity by 2005. There is some municipal support in the area of geothermal heat as well. Private sector involvement in renewable energy promotion exists predominantly in the wind energy and small-scale solar projects [94].

All, the Ministry of Energy and Natural Resources [91], the State Planning Organization (DPT) and the Electric Power Resources Survey and Development Administration (EIEI) are involved in renewable energy promotion policies. Low-interest loans up to 45% of the capital cost are applicable to appropriate investments [95].

Until recently, Free Market Law of Electricity, the price of energy was decided as a result of negotiations between energy production company and the state which is buyer. This was a kind of incentive. Now, the price of the renewable energy will have to obey the market conditions. The subventions given to the renewable energy sources are compulsory till the sector come a competitive point with other energy sectors [96]. In addition, Turkish electricity demand is expected to increase by 7–8% annually, and power shortages are already widespread. In this context, policy makers increasingly recognize the potential role of wind power as part of the country's future energy mix [97].

*2.2.3.3. **Target**.* The Ministry of Energy and Natural Resources [91] is planning for a very large increase in electric generating capacity over the next twenty years, as shown in Table 3. The MENR had

Table 3
Electric power capacity development in Turkey [91,99].

Fuel type	2000		2010		2020	
	Installed capacity (MW_e)	Generation (GWh)	Installed capacity (MW_e)	Generation (GWh)	Installed capacity (MW_e)	Generation (GWh)
Coal	7465	38186	16106	104040	26906	174235
Natural gas	6756	46217	18923	125549	34256	225648
Fuel oil	2124	9531	3246	18213	8025	49842
Renewable	10112	30988	25102	86120	30040	104110
Nuclear	–	–	2000	14000	10000	70000
Total	26457	124922	65377	347922	109227	623835

Table 4
Summary of wind energy policy in different countries.

Country	Principle support (FIT/RPS)	Investment support (e.g. subsidies)	Sales or energy tax exemption	Public loans/ financing	Legislation (e.g. CO_2 emission	Target implementation	R & D support	Strength (highlight)
USA [30–42]	RPS	Yes	Yes	Yes	Yes (25%, 2025)	Yes (25% of supply, 2025)	Yes	Investment & production tax credit
Canada [43–55]	FIT	Yes	–	Yes	Regulatory Framework in 2008	Yes, (12 GW, 2016)	Yes	Production incentive of 1 cent/kWh for the first 10 years
Denmark [56–67]	FIT (1993)	Yes	Yes	–	Yes (50%, 2030)	Yes (200 GW, 2030)	Yes	Tender schemes for off-shore wind
Germany [68–86]	FIT (1991)	Yes	–	Yes	Yes (20%, 2020)	Yes (30 GW, 2010)	Yes	Electricity feed-in tariff
Turkey [87–100]	FIT (2005)	Yes	–	–	–	License up to 10 GW	–	Preparing to join the European Union
Australia [101–119]	FIT	Yes	–	Yes	Yes (60%, 2050)	Yes (10 GW, 2020)	Yes	National Clean Energy Target
China [120–140]	–	Yes	Yes	Yes	–	Yes (total capacity 30 GW, 2020)	–	Locally made components
Japan [141–150]	RPS (2003)	Yes	–	–	Yes (6%, 2012)	Yes (3000 MW, 2010)	Yes	Market incentives and subsidy
Korea [151–156]	FIT (2002)	–	–	–	–	Yes (2250 MW, 2012)	Yes	Feed-in-tariff system
Egypt [157–161]	FIT	Yes	–	Yes	–	Yes (7.2 GW, 2020)	–	Guarantee of a long-term power purchase agreement
Algeria [162–171]	FIT	Yes	–	Yes	Yes (40%, 2020)	Yes (10–12%, 2010)	–	CSP Global Market Initiative

intended that most of the new power plants would be built by foreign developers on a ‘‘Build, Operate and Transfer’’ basis [98].

GHGs emissions are projected to continue decreasing until 2020 in the EU-27, the 20% reduction target compared to 1990, endorsed by European leaders in 2007, will remain out of reach without the implementation of additional measures, such as the EU energy and climate change package proposed by the European Commission in January 2008 and Turkey also took it as their commitment [100].

2.3. Wind energy policy in Australia

Australia is the 14th largest world economy, with energy, with significant air traffic between states and is perhaps unique in also having a wide range of climatic zones, long distances between urban centers, and land use patterns that are still undergoing significant change [101].

2.3.1. Policy

Energy policy of Australia is subject to regulation and fiscal influence of the three levels of Government [102] in Australia; however, State and Federal energy policy deals with primary industries, such as coal [103]. Despite Australia is one of the most coal-dependent countries in the world [104], there is increasing pressure from both the political arena, e.g. Agenda 21 [105] and the Australian Greenhouse Challenge [106] as well as consumer opinion [107] to increase the usage of renewable energy and reduce the greenhouse gas (GHG) emissions [108]. At May 2009, feed-in laws had been passed in Queensland, South Australia and the Australian Capital Territory (ACT), Limited provisions have also been passed in Victoria. The Tasmanian, New South Wales and Western Australia Governments are considering a scheme while the Northern Territory is not currently considering feed-in tariffs [109].

2.3.2. Target

Australia is at the cross-roads in terms of how to meet its future energy requirements in an increasingly ‘carbon-constrained’ multilateral policy environment [110]. At current levels of generation, a shortfall in available electricity is expected within the decade [111]. Federal policy is beginning to change with the publication of the Garnaut report and Carbon Pollution Reduction Scheme White Paper, announcement of an Emissions Trading Scheme to commence in 2010 and announcement of a national mandatory renewable energy target of 20% share of electricity supply in Australia by 2020 [112]. The national Mandatory Renewable Energy Target [112] contains three main objectives:[111].

(i) encourage the additional generation of electricity from renewable sources;
(ii) reduce emissions of greenhouse gases; and
(iii) ensure that renewable energy sources are ecologically sustainable

Australia has one of the highest per-capita greenhouse gas emissions levels in the industrialized world [113]. In part, this is due to its large domestic reserves of coal, which have kept electricity prices low and attracted energy-intensive industry. Currently, coal-fired power provides more than 75% of domestic electricity generation [114]. However, in recent years concerns over climate change have prompted Australian policymakers to

seek mechanisms to increase the proportion of emissions-free renewable energy. As a result, in 2001 Australia became the first nation to introduce a national renewable energy market using tradable certificates [115].

The Labor Party had also announced its commitment to a long-term emissions reduction target of 60% (compared with year 2000 levels) by 2050 as part of their campaign. These policies will gradually begin to level the playing field between wind and other renewable energy and coal power, which holds a 77 per cent share of Australia's electricity generation.

2007 also saw the amalgamation of the Australian Wind Energy Association (Auswind) and the Australian Business Council for Sustainable Energy to form the Clean Energy Council—a single powerful industry voice for the clean energy sector in Australia, which is focusing on ensuring that the details of the RE support scheme deliver investment certainty to wind and clean energy developers.

2.3.3. Incentives

The total operating wind capacity at the end of 2007 was 824 MW. While there were only three new project commitments during 2007 – amounting to $440 million Euros of investment – the 2008 outlook is rosier as a result of the growing political and public support. Significant wind capacity is moving through the project planning stage – with over 400 MW of projects receiving planning approval during 2007 [116,117].

The policy that created this market, called the mandatory renewable energy target [112], requires that electricity retailers source an additional 9500 gigawatt-hours (GWh) of electricity from renewable sources by the year 2010. The Australian government is now expected to replace the MRET with a new national renewable energy target of 45,000 GWh by 2020 [118,119].

2.4. Wind energy policy in Asian Countries

2.4.1. China

China has had double-digit rates of economic growth for much of the past two decades. This growth has had huge implications for energy consumption and environmental impact [120]. One of the environmental problems associated with energy consumption is carbon emissions. Though, China's carbon emissions are low on a per capita basis, China is already ranked the world's second largest producer of carbon emission, behind only America [121,122]. It is reported that 75 percent of China's pollution is due to the burning of Coal as a source of primary energy and this accounts for the dominant share of China's total consumption. Though this share has declined recently, it is still too high relative to other countries [123].

China is endowed with large wind resources in the north, from Xinjiang Autonomous Region through Gansu Province to IMAR, and in the southeast, along the coastline [124]. The total available wind energy in China has been estimated at 3.2 TW; however, the Ministry of Electric Power estimates the exploitable electric potential (at a 10 m height) to be 253 GW [125,126]. Thus far, about 200 MW has been developed through large- and small-scale projects [124]. The Ministry of Electric Power's assessment of wind resource shows that the best wind resources in IMAR cover an area of 83,000 km^2 with an average power density at 10 m of 286 W/m^2 and with 6950 usable hours 6 [127].

The lack of domestic technology and the availability of soft loans are not the only reasons why utility-scale wind development in China has been so difficult. One of the main reasons is that there is no clear, "fixed policy for wind power sales. Each power purchase agreement [128] must be negotiated individually. The power purchase price varies from province to province, as expected for different avoided costs, but in China, the price also can vary by a factor of two in the same province. Fiscal incentives to promote renewable energy are limited and vary from province to province. The process of securing project approvals from the regional and national government, PPA from the utility and project financing appears to be difficult, time-consuming and confusing. Utilities want a complete financing package in place before agreeing to a firm power purchase price; or the SDPC may revoke some approvals for projects in which costs have risen because complete financing packages were not in place before approvals were granted [129].

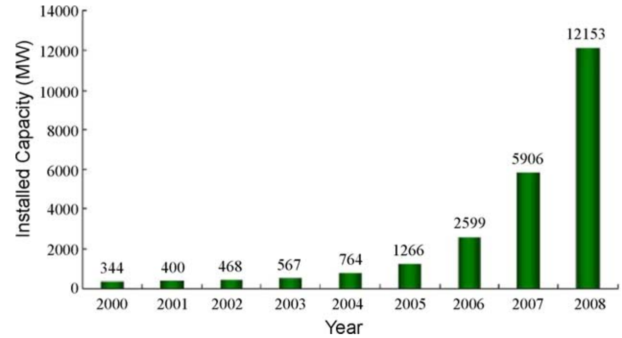

Fig. 13. Total installed capacity of wind turbines in China [132].

The Inner Mongolia Autonomous Region (IMAR) has been a critical supplier of electric energy to the PRC for decades, primarily due to its coal production which is the second largest supplier of coal in China [130]. Grid-connected wind power is well developed in Inner Mongolia, especially after 2005. By the end of 2007, its wind power generation capacity exceeded 1000 MW. The government aims to increase the total wind power capacity in Inner Mongolia to reach 4000 MW by 2010. Wind power developed steadily from 2000 to 2005 in Inner Mongolia, with an annual increase of 16% in installed turbines and 24% in installed capacity [131]. Recently, the off-grid technology has matured. The popular turbine types are 200 W, 300 W, and 500 W turbines, which had aggregately occupied about 65% share of the market in 2008 as shown in Fig. 13 [132].

The Chinese government acknowledges the importance of RE for its energy security and has voiced ambitious targets as shown in Fig. 14 [133]. However, China will be one of the worst impacted regions in the world if climate changes as predicted [134–136]. For example, global warming could make China's agricultural output reduced by 5–10% by 2030 [136], thus adding stress to a country that has 20% of the world's population and only 7% of the arable land. In addition, three main industrial centers of China are on lowland areas: the Gulf of Bohai region with the Beijing-Tianjin axis, the Yangtze River delta radiating inland from Shanghai, and the Pearl River delta encompassing Hong Kong and Guangzhou. A

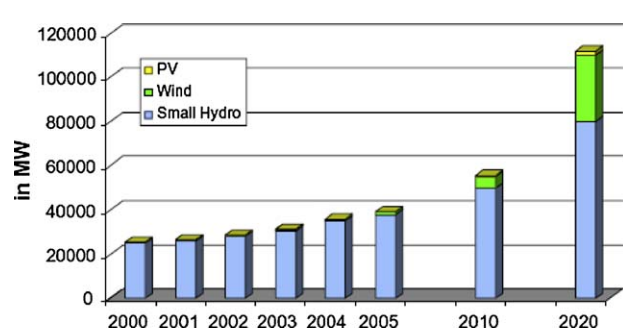

Fig. 14. Development and projections for the installed capacities of selected RE between 2000 and 2020 in MW [137].

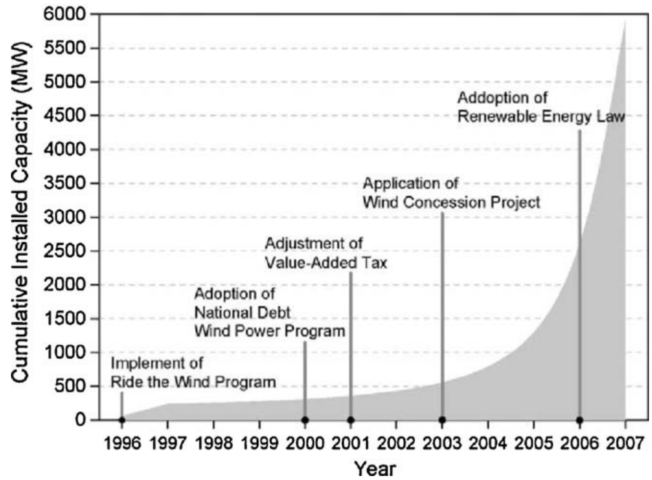

Fig. 15. Political milestones for wind power development in China [140].

sea level rise of a meter would inundate 92,000 km^2 of land in these three regions [134,136].

2.4.1.1. ***Policy.*** Generally, China's policy on renewable energy development falls into three categories. Similar to the way renewable policies are set in the United States, China's central government establishes the first two levels of policy. Local governments, including provincial, municipal, and county governments, establish the third level of policy with overall direction from the central government [138]. The government of China has, since 1996, implemented a few programs regarding the wind energy to stimulate the wind energy industry and the wind turbine manufacturing industry, as explained below.

2.4.1.2. Ride the Wind Program. This program was initiated in 1996 by the former State Development and Planning Commission (SDPC) to import technology from foreign companies and establish a high-quality Chinese wind turbine generator sector. Under this program, wind farm projects approved by SDPC during the Ninth Five-Year Plan (1996–2000) required that wind turbine generator equipment purchased for those projects contain locally made components, which account for at least 40% of the total. This initiative led to the formation of joint ventures in the Chinese market and effectively introduced wind turbine generator manufacturing technology into China [139].

2.4.1.3. National Debt Wind Power Program. The National Debt Wind Power Program was implemented by the former State Economic and Trade Commission to encourage the development of domestic wind power equipment manufacturing and to use national debt with favorable interest subsidy conditions to build wind farms with locally manufactured wind power components for new generation projects. By 2000, this program had established four pilot projects with a total installed capacity of 73 MW. Thus far, this program has been completed [139].

2.4.1.4. Adjustment of value-added tax. In September 2001, the Chinese government reduced the value-added tax for wind power from 17% to 8.5% [139].

2.4.1.5. Wind Power Concession Project. In order to promote the commercialization of wind power, the National Development and Reform Commission (NDRC) adopted the concession approach in 2003 with a 20-year operational period, which have been used relatively successfully for the exploration and development in China's petroleum and natural gas sectors. Through the Wind Power Concession Project, the Chinese government hopes to create further incentives for international and domestic investors to develop large-scale wind farms and to encourage a reduction in the price of wind power within China's reformed electricity industry. The basic approach is to select potential projects of relatively large scale (100 MW), and to choose the investor through competitive bidding. The government guarantees that the on grid power price will be set through process bidding, and ensures that all electricity generated by the wind farms will be purchased. Under this policy, market risk is reduced significantly, which in turn reduces the risk premium of the internal rate of return for wind power projects. From 2003, NDRC has continuously organized rounds of wind concession projects, giving more emphasis on the domestic manufacturing. By the end of 2006, four rounds had raised 15 wind concession projects with a total capacity of 2550 MW. All the projects have started construction, only 25% of which have been completed [139].

2.4.1.6. Renewable Energy Law. In February 2005, China's Renewable Energy Law was formulated and came into force on January 1, 2006. The law requires that power grid operators purchase a full amount of wind power generated by registered producers. The law also offers financial incentives, such as a national fund to foster renewable energy development and discounted lending and tax preferences for renewable energy projects [139].

Since the introduction of these policies, the power generation through wind energy has increased rapidly as shown by Fig. 15. China's wind energy policy can therefore be considered as a successful example to other countries that wish to utilize wind energy as describe in Fig. 14.

2.4.2. Japan

In fact, wind power in Japan accounts for less than 0.3% [141] of the total generation capacity. On the other hand, in Europe it accounts for a larger percentage of the total generation capacity at 13% in Germany and 24% in Denmark [142], representing a growing business. In 1999, the diffusion rate of wind power reached only 0.04%, and other new sources of energy 0.22% [143] in Japan. Even if wind power reaches by 2010, in amounts up to 3000 MW [143,144] which is the target of the Japanese government, the percentage will still remain as small as 1.1% [145].

2.4.2.1. ***Incentives.*** Japan initiated a "Sunshine Project" in 1973 after the first oil crisis as a project to develop and commercialize new energy technologies, including renewable. The New Energy and Industrial Technology Development Organization (NEDO) was established by the Japanese government in 1980, and the "Sunshine Project" was updated to the "New Sunshine Program" in 1993. The government's policy that led to the present diffusion of photovoltaic power generation has included offering subsidies for residential photovoltaic systems (1994), subsidies for wind power systems (1998) and other measures typical of the "technology push" or "initial investment" approach [146].

2.4.2.2. Target & policy. In pursuit of its Kyoto Protocol objectives, Japan has a target to reduce the level of its greenhouse gas emissions by 6% (compared to 1990 levels) in the period 2008–2012. To help achieve this goal, the Japanese government introduced a Renewable Portfolio Standard law in April 2003 with the aim of stimulating renewable energy to provide 1.35% of total electricity supply in 2010 [147]. The official government target for wind power in Japan by 2010 is 3000 MW. However, the law has a number of weaknesses, including a very low target, the inclusion of electricity generated by waste incineration as "renewable" and insufficient market incentives. Apart from the RPS, the Japanese wind industry also benefits from the government's initial subsidies

such as the Field Test and New Energy Business Support Programs [148].

One of the government's energy policy goals prior to PM Hatoyama's announcement was to extend nuclear energy capacity to deliver 40% of the nation's electricity needs by 2030 [149].In addition to R&D support, the Japanese government also Endeavors to promote renewable energy diffusion through legislative means [150].

2.4.2.3. Research and development. The government has, in the last couple of years, investigated the feasibility of offshore projects, and an R&D project is expected to start in 2008. The main present hurdles to the development of offshore wind farms in Japan are social issues, especially public acceptance and compensation for the fishery industry. There are also plans to start R&D for deep offshore wind technology in order to capture the huge potential of wind energy in deep offshore areas around Japan [66].

2.4.3. The Republic of Korea

2.4.3.1. Policy, target and incentive. South Korea is the world's fourth-largest oil importing country, with 97% of its energy consumption provided for by fossil fuel imports. In order to diversify its energy supply, the Korean government in 2003 established its Second Basic Plan for New & Renewable Energy Technology Development and Dissemination, setting a goal of increasing the country's share of renewable energy in total energy supply from 1.05% in 1999 to 5% in 2010. In addition, the plan has a short-term target of meeting 2% of the total energy demand with new & renewable energy sources by 2003 [151].

The priority areas for achieving these objectives are wind energy and solar photovoltaic's (PV), and a target for wind energy was set at 2250 MW by 2012. A report by the International Energy Agency concluded that the country could generate as much as 30% of its electricity from renewable energy sources. However, the proportion of renewable power stood at only 2.3% in 2007 [152].

Since the feed-in-tariff system for RE-generated electricity took effect in May 2002, private investors have been the driving force behind installation of commercial wind power generators. In order to secure private investment, an application period for the base price was established as a guarantee [153].

There are currently 12 wind farms in Korea, made up of more than 120 commercial turbines. The total installed capacity increased by 18 MW in 2007, and the total now stands at 191 MW [154].

2.4.3.2. Creation of a domestic industry. The Korean government is promoting research and development in renewable energy technologies to create a new high technology sector of the economy.

South Korea government in collaboration with Jeju special self-governing province is implementing a wind power project on Jeju Island as a benchmark for NRE development in South Korea. At the end of 2001, 40 units were in operation with a total capacity of 6.6 MW [155].

At present, four domestic manufacturers are developing MW-class wind power generators with capacities of 2–3 MW. The fabrications of 2 MW-class wind turbines have been completed in 2007, and the prototypes will be tested for the type certification during 2008 [66].

The government of the Republic of Korea is setting up a US$72.2 million renewable energy fund to increase renewable energy infrastructure. According to the Ministry of Knowledge Economy, the fund will be used to attract private sector investments in solar, wind and hydroelectric power projects, including technology development and plant construction [156].

2.5. Wind energy policy in Middle Eastern Countries

2.5.1. Egypt

Egypt is oil and gas producing country and its electrical power supply is well developed, with over 98% of households connected to the national grid. The rapid growth rate of domestic power consumption of 7% annually and dwindling oil reserves are starting to put pressure on the Government. Security of energy supply as well as environmental concerns led the Egyptian government to take up the use of renewable energies in its national energy planning as early as the 1980s [157].

The proposed polices to foster increasing wind power contribution to the Egyptian electricity mix consist of two phases:

> During Phase 1, tenders will be issued requesting the private sector to supply power from wind energy. The guarantee of a long-term power purchase agreement will reduce the investors' financial risk. The documents relating to the tender for the Competitive Bids are presently under preparation in cooperation with the World Bank.
>
> Phase 2 will see the implementation of a feed-in-tariff taking into consideration the prices achieved in phase 1. NREA (New and Renewable Energy Agency) has taken the decision to further support the wind energy business by providing resource assessment, necessary data for feasibility studies and technical support for potential project developers. Besides the already earmarked areas, work is underway to earmark other promising areas; these areas will be also available for future wind projects carried out by the private sector.

2.5.1.1. The feed-in-tariff. The Electricity Act aims to introduce mechanisms that will make producing renewable energy more profitable and reduce the reliance on carbon credits. When the law is fully implemented, NREA will not own and operate any more renewable power plants. The act will use power purchase agreements, where the transmission company agrees to purchase electricity from the operator for a set number of years, to guarantee investments in renewable. "The second mechanism is the feed in tariff—an incentive tariff for any developer who would like to build a renewable energy plant. The grid is being committed to purchase from this source on a take or pay contract all of this capacity with this incentive tariff or feed in tariff."

2.5.1.2. Target of renewable energy. In order to increase the usage of renewable energy the New and Renewable Energy Authority (NREA) in Egypt has set specific targets for renewable energy utilization. According to these targets, by the year 2005 the share of electrical energy from renewable sources should increase to 5% of the total amount of electrical energy used in Egypt [158]. Around the year 2005, when the last phase of the wind farm in Za'afarana is completed, the total installed capacity of this farm will reach 600 MW. As a long-term planning about 1000 MW will be installed in the coast of Suez Gulf by year 2012 [159].

In April 2007, the Supreme Council of Energy in Egypt announced an ambitious plan to generate 400 MW of power from wind and will increase the capacity to 600 MW by mid-2010 and 20% of the country's electricity from renewable sources by 2020, including a 12% contribution from wind energy, which is about 7200 MW [160].

2.5.1.3. Subsidies & incentive. In Egypt, subsidies continue to be one of the major items of government expenditures. The latest figures indicate that government subsidies exceed 23% of 2005/2006 total budget spending (exceed LE50 billion) and around 74% of such subsidies are allocated to energy products (excluding electricity).

Due to the rapid increase in oil prices over the last two years, the subsidy bill of energy products has quadrupled. Such an increase has presented a critical challenge for the Egyptian fiscal authority. Starting the fiscal year 2005/2006, fiscal authority has recorded such subsidies, explicitly, in order to reveal the true burden of subsidizing petroleum products and natural gas.

Egypt is committed to phasing out subsidies on oil and gas, and privatizing electricity production and distribution to encourage investment in the wind power sector. It has also reduced tariffs on imported renewable energy equipment such as wind turbines, and established a fund to help offset the marginal costs of deploying these technologies [160,161].

2.5.2. Algeria

The global demand for energy and more specifically clean energy is growing rapidly. Algeria has definitely decided to pursue an active role within the global mobilization for environmental protection and the promotion of sustainable development. Promoting renewable energies is now one of the major pillars of the Algerian policy [162]. The Algerian government has been promoting the use of wind energy by means of a series of laws and official program [163].The government has initiated programs that aim at increasing the use of renewable energy technologies in Algeria, therefore providing green power to isolated villages and combating global climate change, especially greenhouse gas emissions [164].

In July 2002, Sonatrach, Sonelgaz (two public companies) and an Algerian private company (SIM) formed a new, renewable energy joint venture company, called New Energy Algeria (NEAL). NEAL will look at development of solar, wind, biomass, and photovoltaic (PV) energy production. In January 2003, Algeria and the International Energy Agency agreed on technological cooperation in developing renewable energy [162,165].

2.5.2.1. Estimation of the wind resources. A preliminary study of the seasonal and annual evolution mean velocity of the wind, made possible to make a first identification of the windy areas of Algeria. This representation of speed in the form of chart has two objectives: first is to identify the wide areas with good promises of exploitation of the wind power. Second is to highlight the relative variation of the resources through Algeria [165].

2.5.2.2. Feed-in-tariff. Algeria has a feed-in tariff scheme since 2004. The FIT has been established by the executive decree of No. 04-92 of 25 March 2004 concerning the diversification of electricity generation. Tariff payment under the Algerian feed-in tariff scheme is expressed as a percentage of the average electricity price which is set annually by the power market operator. The tariff is paid both for own consumption and for sales to the grid. Only plants with a maximum capacity of 50 MW are eligible for tariff payment. Even though the tariff level can vary every year (due to the connection to the electricity price), tariff payment is guaranteed for the full lifetime of a project [166].

2.5.2.3. Incentives. Within its policy of climate and environment protection, the Algerian Ministry for Energy and Mines fully supports the objective of the CSP Global Market Initiative (GMI) to facilitate and expedite the building of 5000 MWe of CSP worldwide over the next ten years. The Government of Algeria sees ideal opportunities of combining Algeria's richest fossil energy source – the natural gas – with Algeria's most abundant renewable energy source – the sun – by integrating concentrating solar power into natural gas combined cycles. Incentive premiums for CSP projects are granted within the framework of Algeria's Decree 04-92 of March 25th, 2004 relating to the costs of diversification of the electricity production. The incentive premiums of this decree shall attract private investors to implement integrated solar combined cycle plants in Algeria. According to the current power expansion planning of the Ministry for Energy and Mines, the capacity targets for CSP power implementation in Algeria are 500 MW of new ISCCS plants until 2010. With these CSP targets and the new Decree 04-92, Algeria has established the GMI commitment on national solar thermal power market implementation. But beyond this Algeria is looking for a close partnership with the European Union so that Algerian plants may help deliver the green energy needed for Europe to meet its targets. To bring these plans to reality and to enhance the participation of the private sector – both local and international – a new company has been created [161,167].

2.5.2.4. Subsidies. Energy subsidies – government interventions that affect energy prices or costs – are large, widespread and diverse. They vary greatly in size and type among fuels, end-use sectors and countries. They also fluctuate markedly over time. Non-OECD countries account for the bulk of these subsidies, with most of them going to consumption by lowering prices paid by consumers. In OECD countries, most subsidies go to production, usually in the form of direct payments to producers or support for research and development [168].

2.5.2.5. Target. Meanwhile both the Algerian government and the private sector are aware of Europe's commitment to renewable energy sources, in particular the European Union's aim to have 17% of renewable energy in 2010s energy mix. Internally, Algeria has also taken on its own commitment [167]. The share of renewable energy sources in Algeria primary energy supply is relatively low compared with European countries, though the trends of development are positive. One of the main strategic priorities of New Energy Algeria which is Algeria's renewable energy agency (government, SONELGAZ and Sona-trach), is striving to achieve a share of renewable energy sources in primary energy supply of 10–12% by 2010 [169,170].

2.5.2.6. GHGs emission reduction. The electricity production sector emits the largest portion of Algeria's GHG (24.9%) however this might have changed in last few years due to a significant shift to natural gas as a main fuel. The second largest emission source is transportation (11.3%) and third is industry (including constructions) emitting 9.7%. Algeria contributes 0.7% of total global gas emissions. Despite being a large oil and gas producing country, Algeria is one of only two Arab States which has advanced a number for Annex I countries emission reductions (Morocco being the only other Arab country to have done so). This target corresponds to a reduction of at least 40% by 2020 compared to the 1990 levels. In addition, Algeria has recognized the importance of NAMAs in contributing to the achievement of the global goal by delivering a substantial deviation from baseline in developing countries [171].

The wind energy policies of different countries are shown briefly in Table 4.

2.6. Energy policy in Malaysia

Malaysia's energy policy encompasses the supply, utilization and environmental objectives [172]. The potential use of renewable energy in Malaysia is important: only 4% of the hydropower is tapped and 48% of the available biomass waste is used today for energy production [173]. The development of renewable energy in Malaysia is still in the early stage [174]. Throughout the years, the government of Malaysia has formulated numerous energy-related policies to ensure the long-term reliability and security of the energy supply for sustainable social-economic development in the country. These various energy policies included the National Energy Policy (1979), the National Depletion Policy (1980) and the Fuel Diversification Policy (1981, 1999) [175]. One of the main and

Table 5
Energy mix in Malaysia [176,177].

Source	1980 (%)	1990 (%)	2000 (%)	2003 (%)
Oil	87.9	71.4	53.1	6.0
Natural gas	7.5	15.7	37.1	71.0
Hydro	4.1	5.3	4.4	10
Coal	0.5	7.6	5.4	11.9
Biomass	–	–	–	1.1

direct consequences of these strategies is the drastic drop in the contribution of oil to the energy mix from a high of 90% dependence in 1980 down to less than 10% in 2003 as shown in Table 5. In 2003, the remaining contributions to the energy mix were from gas and coal at 71.0% and 11.9%, respectively, with the balance from hydroelectric generation [176,177].

Under the Eighth Malaysian Plan (2001–2005), the Five Fuel Diversification Strategy was implemented with RE regarded as the fifth fuel in the country's energy supply mix. The other four types of energy are oil, gas, coal and hydroelectric. The RE target was set at 5% of the country's electricity generation by the year 2005 [178]. With this target in mind, a reduction of 70 million tonnes of CO_2 will be achieved over a span of a 20 year period. Under this policy, a special committee on Renewable Energy (SCORE) under the Ministry of Energy, Water and Communications [179] launched the SREP. Under this program, the installation of RE resource-based small power plants is encouraged [180]. Some of the implementations regarding renewable energy are shown next.

2.6.1. Pricing-law and quota system

The current Malaysian policy neither has the pricing-law nor the quota system. The price of the Renewable Energy is determined through agreement between utility (e.g. Tenaga Nasional Berhad in Peninsula Malaysia) and developers in the form of Renewable Energy Power Purchase Agreement (REPPA). The price of the electricity is not fixed and price has a range set by Tenaga Nasional Berhad (TNB) distribution between 14 and 17 sen/kWh which is derived based on its studies and experiences of Independent Power Producers (IPPs) whose sizes are much bigger than RE (e.g. IPP—several hundred MW, SREP—below 10 MW), thus economic of scale works to reduce the cost and price. According to the interview with Malaysia Energy Center staffs, even the maximum price of 17 sen/kWh does not provide high enough rate of return to attract investors or project developers given the size of the project under Small Renewable Energy Power (SREP). Also, this price range does not vary according to the size, location, and technology.

Payment mechanism for IPPs and Small Renewable Energy Power developers are different. The two main differences are as follows:

The payment mechanism for IPPs is called "take or pay". The payment consists of two elements. One is capacity payment paid according to the size of the projects and the other is energy payment which is paid according to the amount of electricity the IPPs fed into the grid. The capacity payment is a fixed payment determined solely by the capacity, and energy payment is a variable payment subject to the amount of energy. On the other hand, the mechanism for SREP developers is "take and pay" mechanism. The payment is based only on energy payment (i.e. electricity price per kWh times amount of energy connected to the grid). Thus, the IPPs are paid the fixed amount of capacity payment even though they do not provide any electricity into the grid, while SREP developers are not paid unless they provide electricity.

The price of electricity is reviewed every four years in case of IPPs, while the price is fixed at the price agreed on REPPA which is signed before project starts. The maximum length of the contract is 21 years in both cases. The penalty for developers in case of not meeting the contracted amount of energy fed into the grid for SREP developers is 10% of tariff reduction. In both regards, mechanism of the payment for IPPs is more beneficial to developers or producers rather than that of SREP. Also, the SREP set the cap of 10 MW maximum for developers to sell the electricity to the grid. The size of this 10 MW is the indicator that determines whether the developers are categorized as IPPs or SREP developers. Above 10 MW, the developers are regarded as IPPs not SREP developers. The two main benefits for SREP developers unlike IPPs are (i) SREP developers can enjoy some financial incentives, and (ii) Environmental Impact Assessment is not necessary whose cost may turn some projects not viable [180–182].

2.6.2. Financial incentives

Current energy policy frame work which is now in action in Malaysia is described in Table 6.

2.6.3. Current subsidy for each resource in Malaysia

The current subsidies which are available in energy sector are shown in Table 7.

2.6.4. Pioneer status and investment tax allowance

Project proponents wishing to establish new renewable energy generation capacities have the option to request for Pioneer Status (PS) and Investment Tax Allowance (ITA). A company receiving PS has to pay only tax on 30% of its statutory or taxable income for five years. Companies located in the states of Sabah, Sarawak and the Eastern Corridor states of Peninsular Malaysia have to pay tax on only 15% of their statutory income for five years

A company also has the option of asking for ITA. The ITA is more beneficial if the project involves heavy up-front capital costs and profits are not expected in the initial years of the project. Under the ITA, a company is given an allowance of 60% of qualifying capital

Table 6
Current status of different financial incentives in Malaysia [180].

Systems	Current status	Comments
Tax exemption-income	Pioneer Status of Income tax exemption of 100% for 10 years (or Investment Tax Allowance)	Upgraded from 70% to 100% and 5 years to 10 years in 2004
Tax exemption-investment-based	100% of capital expenditure incurred within a period of 5 years (or Pioneer Status)	Upgraded from 60% to 100% in 2004
Tax exemption-production-based	Not exist	Production incentives with a lump-sum not proportion is better than investment incentives
Import duty exemption	Import duty and sales tax exemption on machinery and equipment which are not produced locally. For machinery and equipment which are produced locally, sales tax exemptions will be given.	None
Rebates	Not exist	Rebates for RE should be implemented with technology standard, net-metering system, and grid-connection standards
Loan	Not exist	Renewable Energy Business Facility is going to be set under BioGen project.

Table 7
Current subsidy for oil, natural gas and RE in Malaysia [180].

Subsidy	Example	Oil	Natural gas	RE
Direct Financial Transfer	Grants to producers or consumers, low-interest loans	Retail price for petrol and diesel is subsidized	Fuel price for power generation is RM 6.40/nmBTU (6.80 in Sabah, 4.41 in Sarawak) compared to normal price of RM 18.00/nmBTU	None
Preferential tax treatment	Rebates, exemption on royalties, tax credit, accelerated depreciation	Tax exemption of 58.62 sen per litter	None	Income Tax Allowance (ITA) or investment tax exemption (Pioneer Status)
Trade restrictions	Quotas, trade embargoes, technical restrictions	None	Contractual fixed trade quota of 250 mscfd to Singapore	None
Energy related services provided by government at less than full cost	Direct investment in energy infrastructure, public R&D		RM 8 million is set aside for energy related activities	
Regulations on energy sector	Demand guarantees, price controls, market access restrictions	None	None	price control of 14–17 sen/kWh
Production limit	None	600 thousand barrel per day	2000 mmscfd per day of which 1300 for power generation	None

expenditure, which can be utilized to offset against 70% of the taxable income. Any unutilized allowance can be carried forward to subsequent years until the whole amount has been used up. The company pays the prevailing corporate tax rate on the balance (30%) of its statutory income. For the states of Sabah and Sarawak, and Eastern Corridor states in Peninsular Malaysia, the allowance is higher at 80%, which can be utilized to offset 85% of the statutory income. The allowance given under the ITA is over and above the normal depreciation allowances permitted in the preparation of financial statements.

Apart from that, under the incentives for Approved Service Projects (ASPs), project proposers undertaking investment in ASPs such as transportation, communication and utility projects can enjoy tax exemption under Section 127 and 1A under Schedule 7B of the Income Tax Act 1967 [180,183,184].

2.6.5. Involvement of research institutions and universities

The research institutes that are involved in renewable energy include SIRIM Berhad, the government research agency. Meanwhile, academic studies from the universities have helped in exploring new energy sources and their possibilities of utilization. In fact, energy conservation, energy efficiency and renewable energy are the topics of interest for most public universities, especially the four research-oriented universities: University of Malaya (UM) on energy conservation in industries and alternative fuels, Universiti Putra Malaysia (UPM) on solar energy and biomass, Universiti Sains Malaysia (USM) on solar energy, PVs and rural energy planning, and Universiti Kebangsaan Malaysia (UKM) on solar energy and fluidized bed combustion [183].

2.6.6. Malaysia energy policy recommendations/suggestions

Malaysia currently does not have a specific policy for wind energy despite the possibility of utilizing this renewable energy. Therefore, considering the success stories of certain countries which are now using wind energy intensively, and considering Malaysia's condition and existing strategies for renewable energy, the following are suggested.

2.6.6.1. Pricing law and quota system. Pricing law is the initial regulatory framework, and quota system may be desirable after the RE market has been well developed and RE technology become compatible with conventional energy technologies. Quota system may be the appropriate system in that situation, as it will lead to competition, which in turn encourage technology development, and reduce costs.

Pricing-law which fixes the price should be implemented. The following should be taken into consideration on deciding the price.

- The price per kWh should be different according to the scale of the project (i.e. price for 5 MW should be different from that of 10 MW).
- Price for each RE technology should be different (i.e. price for biomass should be different from that of wind like many European nations).
- Pricing may need to reflect inflationary effect and also escalation of fuel price or pricing law should be reviewed on a regular basis like IPPs for every four years to reflect these effects and technology development.
- The price should not be calculated based on IPPs examples, as most of the RE are smaller than those, and economy of scale does not work.
- The price should reflect the competing use.
- The discussion for who is going to pay the additional fees is necessary. In most of the cases in European countries, the additional fees are paid by consumers through higher tariff, or government.
- Government can give the same subsidy to RE as conventional energy, or remove current subsidy for conventional and switch to RE.
- Consumers or industry pay additional fee as a carbon, or electricity tax.
- Pricing law should be set along with grid connection standards so as not for utility to interfere the grid connection through expensive charging for grid connection.
- Pricing law should guarantee the long enough time contracts.
- The size constraint of maximum 10 MW for SREP projects should be removed to encourage a bigger project where economic of scale works. It means that any size of the RE projects as long as they utilize RE sources should be given financial incentives for SREP projects. However, these financial incentives should vary according to technology, and size of the projects [180].

The quota system is not recommended to implement now due to the following reasons:

- Administrative cost is too much.
- Tend to create stop-and-go, boom-and-burst market.
- Still lacking in experience in other countries.

2.6.6.2. Financial incentives. The financial incentives or mechanisms should be applied according to the type of technology and purpose of the incentives. For example, to promote technologies such as PV, solar thermal, heat pumps and wind turbines on a small-scale, distributed basis, financial incentives should be set to benefit end customers. On the other hand, to promote large wind,

biomass, or geothermal technologies, the incentives should be aimed at encouraging investment by a large entity or company.

Current PS and ITA are not the appropriate financial incentives for development of RE in Malaysia. Pioneer status of income tax exemption can be used for tax evasion, and does not guarantee production of RE which does not always encourage domestic manufacturing as firms may purchase RE technologies from abroad. Investment tax exemption without technology standards can be also used for tax evasion, be beneficial to rich, and does not guarantee production of RE.

Instead of investment tax exemption, rebate which refunds a certain amount of capital expenditure is recommended for small-scale, residential-use, or off-grid technologies, such as wind, biomass and geothermal energy systems. Also, it is beneficial for technologies whose initial expenditure is still expensive such as wind turbine installation. Investment incentives should come along with technology standards to avoid subordinate technologies from being utilized.

For large scale or commercial/industry-use biomass, wind, and hydro, performance-based incentives especially rebates for amount of electricity fed into grid rather than tax exemption is desirable. Performance-based incentives are strongly recommended to give incentives for developers to provide electricity stably in order to avoid penalty due to shortage of minimum uptake. This can be also suggested as a solution for removing penalties item from REPPA to encourage developers to do their maximum efforts to meet the contracted amount of energy fed into the grid. The main reason why penalties should be removed in REPPA is that SREP projects are very small compared to IPPs. In case SREP developer could not provide contracted amount of electricity due to maintenance reasons, for example, the developers are not paid at all for that period unlike IPPs, which are at least guaranteed fixed amount of payment and also the payment may be penalized as it could not meet the monthly requirement. These double negative impacts makes the small RE projects easily unviable.

As for loan, as seen in Thailand on petrol or other countries on energy, a small extra charge on electricity per kWh can be collected for RE fund for loan on RE projects. This fund can be also used for other RE-related activities, such as R&D, education, information dissemination, or financial use as rebates. The appropriate commodities may be natural gas or petroleum or all fossil fuels to levy this tax [180].

2.6.6.3. Subsidies. In order to level the playing field for RE, the subsidies for conventional energy should be gradually removed or transferred to RE otherwise the same subsides should be given to RE for the time being. Removal of subsidies does not always worsen the economy but rather boost it due to efficient use of energy.

The reforms of subsides can be done over a certain period of time to reduce the political barrier and sometimes with compensating measures. For example, if the subsidies are removed, offset mechanism should be introduced by giving other financial incentives to increase the use of RE such as tax exemption for the utilities that suffer from increase of production cost, and also social security for consumers which will suffer from increase of consumer price.

Timing matters for subsidy reform because sudden shock can deteriorate domestic economics. Thus energy price reform should be announced in advance so that utilities can shift from conventional energy sources to RE source besides giving incentives for RE [180].

2.6.6.3.1. Rational for Subsidy in Malaysia. The role of the subsidies is very controversial. Following is the suggested justification of subsidies in Malaysia.

- Increase of energy price due to the removal of energy subsides hinder the foreign direct investments.
- Poor cannot afford the increased price and benefits and welfare gained can be higher than long-term costs in providing subsides.
- Despite the detrimental effect of subsides, it is politically difficult to remove them partly because its short term costs that energy removal would entail.

2.6.6.4. Local components in wind turbines. Wind energy industry includes not just the power generation industry but also the wind turbine manufacturing industry. There are only a few wind turbine manufacturers that can provide wind turbine if wind power generation is to be produced.

According to China's wind energy policy, the former State Development and Planning Commission (SDPC), in 1996, launched a program called 'Ride the Wind Program'. Under this program, wind farm projects approved by SDPC during the Ninth Five-Year Plan (1996–2000) required that wind turbine generator equipment purchased for those projects contain locally made components, which account for at least 40% of the total [139]. A program like this is very useful when a country is in its initial phase of exploring an industry.

Hence, Malaysia can adopt the strategy of encouraging local components in wind turbines since the country is in its early phase of utilizing wind energy. In more practical terms, government can define locally manufactured wind turbine as those consisting at least 40% components by local suppliers. In fact, similar strategy was also used during the 1980s to stimulate the Malaysia national car project, in which every national car produced must have certain percentage of local components to gain the national car status.

2.6.6.5. Increase in energy research and development (R&D). Wind energy has been a topic of interest for many local academics and engineers. This is probably because wind energy is still new in Malaysia and its potential has not yet been fully discovered. The current situation in Malaysia is that most of the researches are done by academics in public universities like UM, USM, UPM, UKM, which are researched oriented, and not to mention others like University Technology Malaysia [185].

R&D is essential to improve the technology of utilizing wind energy, and thus it can also help to increase the wind power generation in Malaysia. If a policy is to be made, it should include encouragement to wind energy R&D. A practical and usually effective way is to provide greater budget for research work regarding wind energy. This suggestion is supported by the Japan's starting R&D in 2008 for deep offshore wind technology in order to capture the huge potential of wind energy in deep offshore areas around Japan. Researches done on wind energy in Malaysia can also focus on the offshore areas.

Ideally, R&D on wind energy is collaboration between the universities and the industry. It is strongly suggested that the allocated budget should not only be used in university research but allocation must also be given to private sectors which carry out R&D in wind energy and related studies [180].

3. Conclusion

In a nutshell, wind energy, which is a type of renewable energy, has the potential to be utilized for power generation. Power generated by wind energy is not just relatively simpler but is also much more environmental friendly compared to power generation using non-renewable sources like the fossil fuels and coals. Considering that energy usage worldwide has been increasing throughout the years, switching to wind energy can be a viable move.

From the study, it is obvious that almost all countries that utilize wind energy for power generation have policies specific to wind energy. Some of the success stories include wind energy

utilization in USA, Canada, Denmark, Germany, Turkey, Australia, China, Japan, and South Korea. For these countries, the existence of wind energy policies managed to increase wind power generation significantly. In general, most countries' policies include tax exemption, the quota system, subsidies, Feed-in Tariff, involvement of research institutions, target implementation, legislation on wind energy or renewable energy law and others.

The current situation in Malaysia shows that there is no specific policy on wind energy, since wind energy is a relatively new issue to the country and its potential has not been fully explored. However, there are still some strategies that apply to renewable energy, like the tax reduction for PS and ITA. Therefore, it is concluded that a wind energy policy is needed if wind energy is to be seriously utilized in Malaysia.

It is hope that by having a proper wind energy policy framework and by effective implementation the above suggestions, the wind energy utilization and its related industries can be stimulated and explored fully.

Acknowledgement

The authors would like to acknowledge the University of Malaya for funding the project. The research has been carried out under the Project no. RG056/AET09.

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